REFUTATION OF THE CLAIMS OF G. BRUHN

The relevant e mail posting by G. Bruhn is appended. Bruhn posted this without my knowledge, and apparently it is an unrefereed document. Bruhn refers to none of my recent work which is now universally acclaimed and accepted. Here I comment on Bruhn's posting section by section.

Section 1.

This is merely a quote by Bruhn of some of my earliest work on $\underline{B}^{(3)}$, almost a decade ago.

Section 2

The first elementary error in Bruhn's claims occurs in his equations (2.3) and (2.4). It is easy to show that Bruhn has made an elementary blunder because when we add his eqs (2.3) and (2.4) we obtain:

$$\underline{B}^{(1)}(\text{left}) + \underline{B}^{(1)}(\text{right}) = B^{(0)}\underline{e}^{(1)}\left(e^{i\phi} + e^{-i\phi}\right) \quad -(1)$$

$$= \frac{B^{(0)}}{\sqrt{2}}\left(\underline{i} - i\underline{j}\right)\left(e^{i\phi} + e^{-i\phi}\right)$$

$$= \frac{B^{(0)}}{\sqrt{2}}\left(\underline{i} - i\underline{j}\right)\cos\phi \quad -(2)$$

However, it is well known that the sum of left and right circular polarization is linear polarization. Bruhn's eqn (2) is still circular polarization

2) The correct way to represent left and right circular polarization is as follows:

$$\underline{B}_L^{(1)} = \frac{1}{\sqrt{2}} \left(B_x \underline{i} - i B_y \underline{j} \right) e^{i\phi} \quad - (3)$$

$$\underline{B}_R^{(1)} = \frac{1}{\sqrt{2}} \left(B_x \underline{i} + i B_y \underline{j} \right) e^{i\phi} \quad - (4)$$

Add (3) and (4) to obtain:

$$\underline{B}_L^{(1)} + \underline{B}_R^{(1)} = \frac{2}{\sqrt{2}} B_x \underline{i}\, e^{i\phi} \quad - (5)$$

which is linear polarization as required.

In fact I have mentioned the chirality question in my writings many times (e.g. Adv. Chem. Phys. vol 85). This shows that Bruhn is almost completely ignorant of my work. The rest of Bruhn's claim is sequentially erroneous, and furthermore, contains other elementary blunders.

Section 3.

In this Section, Bruhn quotes my well-known B Cyclic Theorem.

Section 4

From eqn (3) we see that the left CP wave is

$$\underline{B}_L^{(1)} = \frac{1}{\sqrt{2}} \left(B_x \cos\phi \, \underline{i} + B_y \sin\phi \, \underline{j} \right) \quad - (6)$$

3) From eqn. (4) we see that the right CP wave is

$$\underline{B}_R^{(1)} = \frac{1}{\sqrt{2}}\left(B_x \cos\phi\, \underline{i} - B_y \sin\phi\, \underline{j}\right) \quad -(7)$$

Eqn. (6) is Bruhn's eqn. (4.2) and eqn. (7) is Bruhn's eqn. (4.1~~3~~). This shows that my eqns (3) and (4) give Bruhn's own definitions of left and right handed C.P. in his eqns (4.1) and (4.2). Bruhn's eqns (4.1) and (4.2) therefore contradict Bruhn's eqns (2.3) and (2.4), because when we add Bruhn's eqns (4.1) and (4.2) we obtain linear polarization, but when we add eqns (2.3) and (2.4) we obtain circular polarization.

These errors already make nonsense out of Bruhn's unfounded claim, but his main error is to confuse what is meant by $\underline{B}^{(3)}$. I have written many times that $\underline{B}^{(3)}$ is equal and opposite for left and right handed circular polarization, and for this reason vanishes in ~~CP~~ linear polarization. Mathematically:

$$\underline{B}_R^{(3)} = -\frac{i}{B^{(0)}}\,\underline{B}_R^{(1)} \times \underline{B}_R^{(2)} = -\frac{iB^{(0)2}}{2B^{(0)}}\begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ 1 & i & 0 \\ 1 & -i & 0 \end{vmatrix} \quad -(8)$$

$$= i^2 B^{(0)}\,\underline{k} = -B^{(0)}\,\underline{k}$$

$$\underline{B}_L^{(3)} = -\frac{i}{B^{(0)}}\,\underline{B}_L^{(1)} \times \underline{B}_L^{(2)} = -\frac{iB^{(0)2}}{2B^{(0)}}\begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ 1 & -i & 0 \\ 1 & i & 0 \end{vmatrix} \quad -(9)$$

4) $\underline{B}_L^{(3)} = -i^2 B^{(0)} \underline{k} = B^{(0)} \underline{k}$

Thus: $\boxed{\underline{B}_R^{(3)} = -\underline{B}_L^{(3)}}$ — (10)

The glaring error in Bruhn's claims occurs in his eqn (4.5), where he asserts that for linear polarization:

$$\underline{B}^{(3)} =? \pm \sqrt{2} B^{(0)} \underline{k} \quad - (11)$$

The reason for the erroneous eqn. (11) appears to be confusion about what is meant by $\underline{B}^{(3)}$. The latter is well-defined in my work as existing for one photon. One photon is either left handed, in which case we obtain eqn (9), or right handed, in which case we obtain eqn (8). If we superimpose one left handed photon with one right handed photon we obtain $\underline{B}^{(3)} = \underline{B}_L^{(3)} + \underline{B}_R^{(3)} = \underline{0}$. The B Cyclic Theorem always applies to one sense of polarization.

Therefore the claim by Bruhn is false, and unscholarly, i.e. it is made in ignorance of the literature.

MWE.

Refutation of Myron W. Evans' $B^{(3)}$ field hypothesis

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Summary. In 1992 Myron W. Evans published a paper [1] where he proposed the hypothesis that each circularly polarized plane electromagnetic wave – in addition to its Maxwellian transversal components – should have a longitudinal component of magnitude $B^{(3)} = B_0/2^{½}$ compared with the real magnetic flux amplitude B_0 of the circularly polarized plane wave. Two years later, in a paper [2] he added so-called "cyclical relations" that should hold between the components of the flux **B** relative to a certain complex basis $\mathbf{e}^{(1)}$, $\mathbf{e}^{(2)}$, $\mathbf{e}^{(3)}$ for general plane waves. By application to the superposition of two circularly polarized plane waves to a linearly polarized wave we show here that Evans' "cyclical relations" cannot hold generally. The assumption of a longitudinal $\mathbf{B}^{(3)}$ field leads to a contradiction. This affects especially the paper [4], where a kind of PMM, the MEG, is justified by means of the $\mathbf{B}^{(3)}$ field.

1. Evans' circular basis (taken from [3] , p. 7-14, with slight corrections)

Let (x,y,z) denote Cartesian coordinates with unit vectors **i**, **j**, **k** parallel to the corresponding axes. Evans assumes the z-direction to be the direction of propagation of a plane electromagnetic wave. The letter i denotes the imaginary unit as usual.

Evans replaces the Cartesian unit vectors **i**, **j**, **k** with another system of unit vectors called circular basis

(1.1) $$\mathbf{e}^{(1)} = (\mathbf{i} - \mathrm{i}\,\mathbf{j})/2^{½} \qquad \mathbf{e}^{(2)} = (\mathbf{i} + \mathrm{i}\,\mathbf{j})/2^{½} \qquad \mathbf{e}^{(3)} = \mathbf{k}\,.$$

This means that a certain unitary coordinate transform is executed.

We suppose the coordinates a_x, a_y, a_z of all vectors $\mathbf{a} = a_x\,\mathbf{i} + a_y\,\mathbf{j} + a_z\,\mathbf{k}$ to be real. Then from

$$a_x\,\mathbf{i} + a_y\,\mathbf{j} + a_z\,\mathbf{k} = \mathbf{a} = a^{(1)}\,\mathbf{e}^{(1)} + a^{(2)}\,\mathbf{e}^{(2)} + a^{(3)}\,\mathbf{e}^{(3)}$$

we obtain the transformation rule for coordinates

(1.2) $$a^{(1)} = 2^{-½}\,(a_x + \mathrm{i}\,a_y), \qquad a^{(2)} = 2^{-½}\,(a_x - \mathrm{i}\,a_y), \qquad a^{(3)} = a_z.$$

Evidently the coordinates fulfil the equation

(1.3) $$|a^{(1)}|^2 + |a^{(2)}|^2 + |a^{(3)}|^2 = a_x^{\ 2} + a_x^{\ 2} + a_x^{\ 2} = |\mathbf{a}|^2\,.$$

Additionally the vector components of **a** relative to the circular basis are defined by

(1.4) $$\mathbf{a}^{(1)} = a^{(1)}\,\mathbf{e}^{(1)}, \qquad \mathbf{a}^{(2)} = a^{(2)}\,\mathbf{e}^{(2)}, \qquad \mathbf{a}^{(3)} = a^{(3)}\,\mathbf{e}^{(3)}.$$

Let …* denote the conjugate complex of the term where * is attached. Then evidently we have the symmetry properties

(1.5) $$\mathbf{e}^{(1)*} = \mathbf{e}^{(2)}, \qquad \mathbf{e}^{(2)*} = \mathbf{e}^{(1)}, \qquad \mathbf{e}^{(3)*} = \mathbf{e}^{(3)}$$

(1.6) $$\mathbf{a}^{(1)*} = \mathbf{a}^{(2)}, \qquad \mathbf{a}^{(2)*} = \mathbf{a}^{(1)}, \qquad \mathbf{a}^{(3)*} = \mathbf{a}^{(3)}$$

and

(1.7) $$a_1 = a_2^{\,*}, \qquad a_2 = a_1^{\,*}, \qquad a_3 = a_3^{\,*}.$$

By direct calculation one can obtain the cyclic cross product rules

(1.8) $$\mathbf{e}^{(1)}\times\,\mathbf{e}^{(2)} = \mathrm{i}\,\mathbf{e}^{(3)*}, \qquad \mathbf{e}^{(2)}\times\,\mathbf{e}^{(3)} = \mathrm{i}\,\mathbf{e}^{(1)*}, \qquad \mathbf{e}^{(3)}\times\,\mathbf{e}^{(1)} = \mathrm{i}\,\mathbf{e}^{(2)*}.$$

2. Evans $B^{(3)}$ hypothesis from 1992

In 1992 Myron W. Evans published a paper [1] where he proposed the hypothesis that a monochrome circularly polarized plane electromagnetic wave should have - in addition to its Maxwellian transversal components - a longitudinal component the size of which will be specified at the end of this section.

We assume the speed c of light to be 1. Then a monochrome Maxwellian circularly polarized plane wave propagating in z-direction with amplitude $B_0 > 0$ is given by the equations

(2.1) $$B_x = B_0 \cos \omega(t-z), \qquad B_y = \pm B_0 \sin \omega(t-z), \quad B_z = 0$$

Here the sign $\pm$ in B_y determines the chirality of the polarization: The + sign is valid for left circular polarization and the – sign for right circular polarization. Introducing the abbreviation

(2.2) $$B^{(0)} = 2^{-½} B_0$$

the components of the Maxwellian **B** relative to Evans' circular basis can be written as

(2.3) $$\mathbf{B}^{(1)} = \mathbf{e}^{(1)} B^{(0)} e^{i\omega(t-z)}, \qquad \mathbf{B}^{(2)} = \mathbf{e}^{(2)} B^{(0)} e^{-i\omega(t-z)}$$

in case of left circular polarization and

(2.4) $$\mathbf{B}^{(1)} = \mathbf{e}^{(1)} B^{(0)} e^{-i\omega(t-z)}, \qquad \mathbf{B}^{(2)} = \mathbf{e}^{(2)} B^{(0)} e^{i\omega(t-z)}$$

in case of right circular polarization.

The hypothesis of Evans' paper [1] is that a monochrome circularly polarized plane electromagnetic wave should have - in addition to its Maxwellian transversal components - a longitudinal component of magnitude $B^{(3)} = B^{(0)}$, i.e.

(2.5) $$\mathbf{B}^{(3)} = \mathbf{e}^{(3)} B^{(0)}.$$

He does not mention whether there should be a sign dependency on the chirality of the circularly polarized wave.

In summary may be said that the equations (2.3-5) describe the Evans version of a circularly polarized wave, while for the Maxwellian circularly polarized wave equation (2.5) has to be replaced with $\mathbf{B}^{(3)} = \mathbf{0}$.

3. Evans' Cyclic Relations

In 1994 Evans supplemented his former hypothesis from 1992 by another paper [2]. Here he starts with the statement that the magnetic flux vector **B** of each circularly polarized plane wave that he had equipped in [1] with the additional longitudinal component (2.5) fulfils the "cyclic relations"

(3.1) $$\mathbf{B}^{(1)} \times \mathbf{B}^{(2)} = i\, B^{(0)} \mathbf{B}^{(3)*},$$

(3.2) $$\mathbf{B}^{(2)} \times \mathbf{B}^{(3)} = i\, B^{(0)} \mathbf{B}^{(1)*},$$

(3.3) $$\mathbf{B}^{(3)} \times \mathbf{B}^{(1)} = i\, B^{(0)} \mathbf{B}^{(2)*},$$

which can be confirmed easily by means of the equations (2.2-5).

Evans' new hypothesis of 1994 generalizes the equations (3.1-3) to general waves in vacuo [2, p. 69]: *"We assert therefore that in classical electrodynamics there are three components* $\mathbf{B}^{(1)}$, $\mathbf{B}^{(2)}$ *and* $\mathbf{B}^{(3)}$ *of a travelling plane wave in vacuo. These are interrelated in the circular basis by equations (3.1-3). The third component, the ghost field*

$$\mathbf{B}^{(3)} = \mathbf{B}^{(1)} \times \mathbf{B}^{(2)} / (i\, B^{(0)}) = B^{(0)} \mathbf{k}$$

is real and independent of phase."

Hence Evans' cyclic equations should be valid for the superposition of circularly polarized plane waves too. This is it what we will check now.

4. Superposition of circularly polarized waves

The superposition of a right circularly polarized wave with its left circularly polarized counterpart yields linearly polarized plane waves. If we superpose the right circularly polarized wave

(4.1) $$\mathbf{B}_r = B_0 [\mathbf{i} \cos \omega(t-z) - \mathbf{j} \sin \omega(t-z)]$$

and the left circularly polarized wave

(4.2) $$\mathbf{B}_l = B_0\,[\mathbf{i}\cos\omega(t-z) + \mathbf{j}\sin\omega(t-z)],$$

we obtain the linearly polarized wave

(4.3) $$\mathbf{B} = 2B_0\,\mathbf{i}\cos\omega(t-z), \qquad \text{i.e.} \qquad B_x = 2B_0\cos\omega(t-z), \quad B_y = B_z = 0.$$

Due to Evans both circularly polarized waves should be accompanied by ghost fields $\mathbf{B}_r^{(3)}$ and $\mathbf{B}_l^{(3)}$ which give the resulting sum field

(4.4) $$\mathbf{B}^{(3)} = \mathbf{B}_r^{(3)} + \mathbf{B}_l^{(3)}$$

But due to the indeterminacy of the sign of the additional Evans field for circularly polarized waves we have to discuss all combinations of signs: the cases of constructive and destructive superposition of the corresponding Evans fields. The resulting Evans field for linearly polarized plane waves could be

(4.5) $$\mathbf{B}^{(3)} = \mathbf{0} \qquad \text{or} \qquad \mathbf{B}^{(3)} = \pm\, 2^{1/2} B_0\,\mathbf{k}.$$

We have to check whether there is a combination that fulfils the cyclic equations (3.1-3):

Due to the rules (1.2) the linearly polarized wave (4.3) yields

(4.6) $$B^{(1)} = 2^{1/2}(B_x + i\,B_y) = 2^{1/2} B_0\cos\omega(t-z), \qquad B^{(2)} = B^{(1)*} = 2^{1/2} B_0\cos\omega(t-z).$$

Hence we get:

Case $B^{(3)} = \mathbf{0}$

Then the equation (3.1) leads to a contradiction, since we obtain

(4.7) $$\mathbf{B}^{(1)} \times \mathbf{B}^{(2)} = B^{(1)} B^{(2)}\,\mathbf{e}^{(1)} \times \mathbf{e}^{(2)} = 2\,B_0^2\cos^2\omega(t-z)\; i\,\mathbf{k} \neq \mathbf{0} = i\,B^{(0)}\,\mathbf{B}^{(3)}.$$

Cases $B^{(3)} = \pm\, 2^{1/2} B_0$

Each of the equations (3.2) and (3.3) yields $B^{(0)} = B^{(3)}$. Therefore the right side of (3.1) gives

(4.8) $$i\,B^{(0)}\,\mathbf{B}^{(3)*} = i\,B^{(3)2}\,\mathbf{k} = 2\,i\,B_0^2\,\mathbf{k}.$$

But for the left side of (3.1) we obtain

(4.9) $$\mathbf{B}^{(1)} \times \mathbf{B}^{(2)} = B^{(1)} B^{(2)}\,\mathbf{e}^{(1)} \times \mathbf{e}^{(2)} = 2\,B_0^{(2)}\cos^2\omega(t-z)\; i\,\mathbf{k}$$

Hence we have a contradiction again.

Thus Evans' cyclic equations do not hold for the superposition of two circularly polarized plane waves to a linearly polarized plane wave.

Hence the validity of Evans' cyclic equations, of the base of Evans' O(3) theory, is refuted.

References

[1] M. W. Evans: The elementary static magnetic field of the photon, Physica B **182** (1992) 227-236.

[2] M. W. Evans: The photomagneton $B^{\wedge(3)}$ and its longitudinal ghost field $\mathbf{B}^{(3)}$ of electromagnetism, Foundations of Physics Letters, Vol. 7, No. 1 (1994) 67 - 74.

[3] M. W. Evans: The Enigmatic Photon, Vol. **5**, Kluwer Academic Publishers 1999, ISBN 0-7923-5792-2 .

[4] M. W. Evans e.a. : Explanation of the **M**otionless **E**lectromagnetic **G**enerator (MEG) with O(3) Electrodynamics; Foundations of Physics Letters, Vol. **14** No. 1 (2001)